

R.M.U. USE ONLY
PROBLEM STATEMENT NO:
DATE OF RECEIPT:



STAGE I RESEARCH PROBLEM STATEMENT

I. PROBLEM TITLE (required):

100% Fly Ash Concrete with Recycled Pulverized Glass Aggregate for use in Transportation Related Applications

II. PROBLEM STATEMENT (required):

In recent years, echoing public interest, the transportation industry has become more focused on sustainability, energy reduction, and the reduction of environmental impacts. This focus is highlighted by the creation of the FHWA and EPA Green Highway Partnership. A critical theme identified by this initiative is the reuse and recycling of industrial byproducts and other waste materials. The proposed project follows this theme and will focus on the development and deployment of a sustainable, environmentally friendly concrete suitable for transportation applications. In addition to being well aligned with national goals, the proposed research is also consistent with Governor Schweitzer's initiatives to reduce energy consumption statewide and reduce the environmental impact of coal-based industries.

While frequently used in the transportation infrastructure due to its outstanding engineering properties, the environmental impacts of using concrete as a construction material are significant, ranging from the CO₂ emitted during its production and transportation, to the disturbance of virgin land for the production of aggregates and the extraction of limestone. It has been reported, for example, that the production of cement accounts for 7% of worldwide greenhouse gas emissions (from calcination of limestone and fuel combustion). Therefore, there is a compelling need for alternative "greener" materials for use in construction. Furthermore, if these "greener" materials are generated from common waste-streams, the environmental benefits are two-fold: reduced impacts from the manufacturing of building materials and reduced stockpiling of common waste products. The focus of the proposed project realizes both of these benefits through the use of fly ash (a byproduct of burning coal to generate electricity) as a replacement for 100% of the Portland cement in concrete and the use of recycled glass as a replacement for traditional aggregate.

Preliminary research investigating the use of recycled pulverized glass in 100% fly ash concrete has been conducted at MSU using ash from the Corette Power Plant in Billings with favorable results. The material, produced using conventional construction equipment, obtained high compressive strengths (in excess of 7,000 psi), demonstrated excellent durability (minimal alkali silica reactivity, adequate freeze-thaw resistance), and performed well in structural beams. This preliminary work culminated in a full-scale demonstration project in which this material was used in Missoula, MT by MacArthur, Means & Wells (MMW) Architects on a commercial building for the Missoula Federal Credit Union (MFCU). This material was used in multiple nonstructural and structural elements including the foundation walls and footings, slabs, and two load-bearing beams.

Before this new concrete can similarly be used in transportation projects, additional research is required to further investigate its fundamental properties and the applicability of existing design procedures appropriate to this type of use.

III. RESEARCH PROPOSED (required):

The proposed research is divided into two phases.

Phase I will comprise of additional laboratory tests required to utilize 100% fly ash concrete with pulverized glass aggregate in transportation applications. The fundamental strength and durability properties to be tested in Phase I will be flexural tensile strength, abrasion resistance, and fatigue sensitivity. Additionally, a scaled bridge deck panel will be constructed and tested in flexure to investigate the material's performance in this structural application, as well as to determine the applicability of existing design procedures to this use.

Phase II will entail a large-scale demonstration project in which a fly ash and glass bridge deck is designed, instrumented, constructed, and monitored. Conventional construction equipment will be used for this demonstration project to highlight the ease with which this new concrete can be used in practice.

IV. IT COMPONENT (required):

The work proposed herein does not require IT hardware, software, or support.

V. URGENCY AND EXPECTED BENEFITS (required):

The benefits to society and the state of Montana as a result of this research are obvious and twofold; the myriad of environmental impacts associated with reinforced concrete construction will be reduced, and a new use for two common waste streams will be created. In moving ahead with this work it is important to note that this new material is not expected to eliminate conventional concretes made with Portland cement and traditional aggregates; existing sources of useable fly ash and glass are insufficient to satisfy society's demand for concrete. This work will result in a viable environmentally attractive alternative to traditional concretes, and an increased interest and motivation to pursue use of other environmentally friendly materials in concrete. The bridge deck demonstration project completed in Phase II will be one of the worlds first 100% recycled bridge decks and should receive national attention.

In addition to the obvious environmental advantages of this material, other benefits include (1) reduced construction time: this material gains strength quickly and can be placed into service earlier than conventional concrete, and (2) reduced costs: as a byproduct, fly ash typically is less expensive than Portland cement.

VI. IMPLEMENTATION PLAN (required):

When this project is complete and dependent on its outcome, MDT will have a new "green" concrete available for use on its projects. The mixture proportions, batching procedures, material properties, and structural performance will be documented in the final report for the project. This information will be used as appropriate to develop standard specifications for the material, and/or to identify additional work that must be done to move this material forward for such standard use.

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Note: Submitter may attach continuation sheets if necessary.